TURBINE POWER SYSTEMS CONFERENCE

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Moody Gardens Hotel
Galveston, Texas

Presentation topic:

Technology Development Needs for Coal-Fired Power Systems

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Coal Utilization Research Council (CURC)

What is the Coal Utilization Research Council?

- Promotes coal utilization R,D & D
- Encourages industry/government partnerships to commercialize new coal technologies
- Coordinates activities with other coal stakeholders to insure an industry unified voice on R,D & D

Coal Utilization Research Council (CURC)

Who are the members of CURC?

Utilities as users of technology

Manufacturers of technology/equipment

Producers of coal

R&D technology developers & researchers (including state governments, universities & research institutions)

Coal is Abundant, Affordable & Clean

Soon?

Methane Hydrates

World reserves estimated at up to 400 Million Tcf

Coal

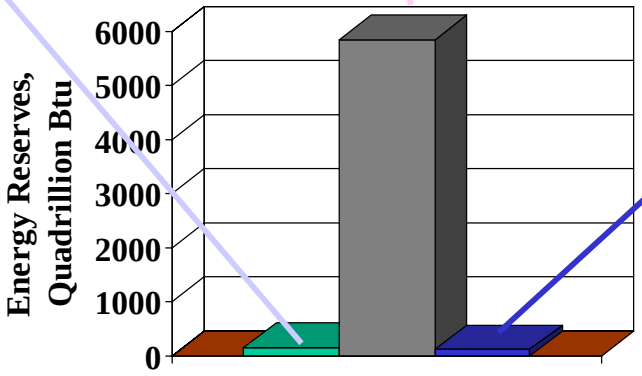
275 billion tons

5,839 Quads

Natural Gas

More than 164 Tcf

168 Quads



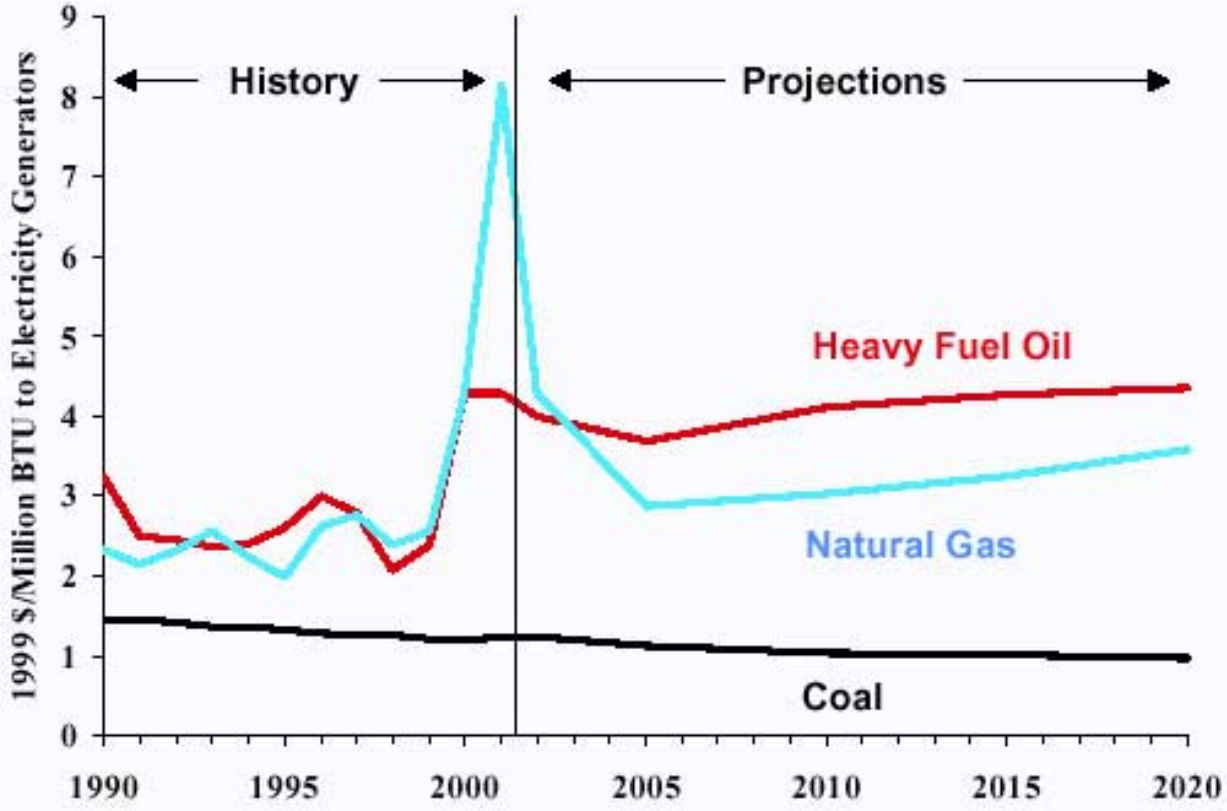
Oil

21 billion barrels

122 Quads

Coal: Abundant, Affordable & Clean

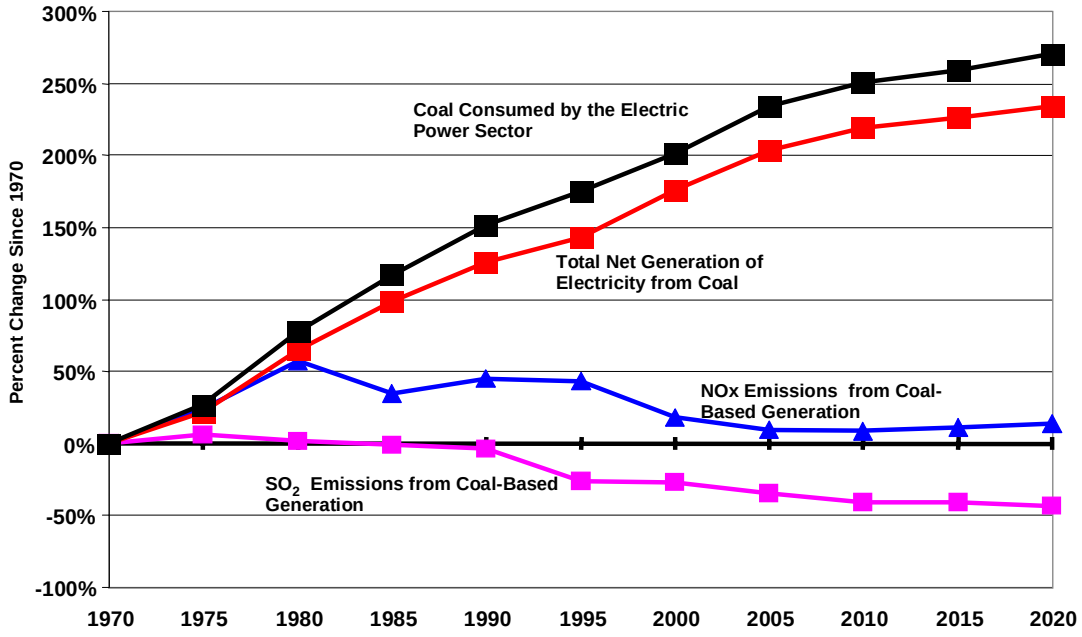
Stable Coal Prices
Erratic Natural Gas Prices



Data Sources: EIA Short Term Energy Outlook, July 2001
EIA Annual Energy Outlook 2001

Coal: Abundant, Affordable & Clean

Since 1970, coal-based electric generation has increased dramatically, yet emissions from coal-based power plants have declined steadily.

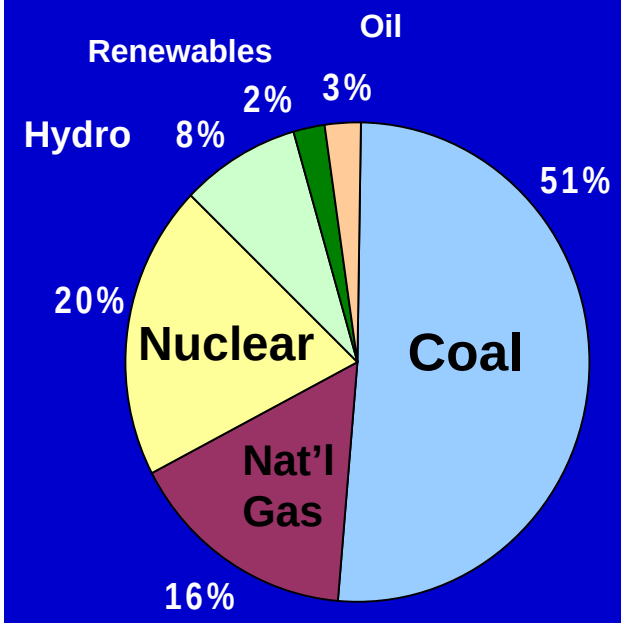


Source: EPA 1999 and EIA 2000

Projection of U.S. Electric Power Generation and Fuel Mix

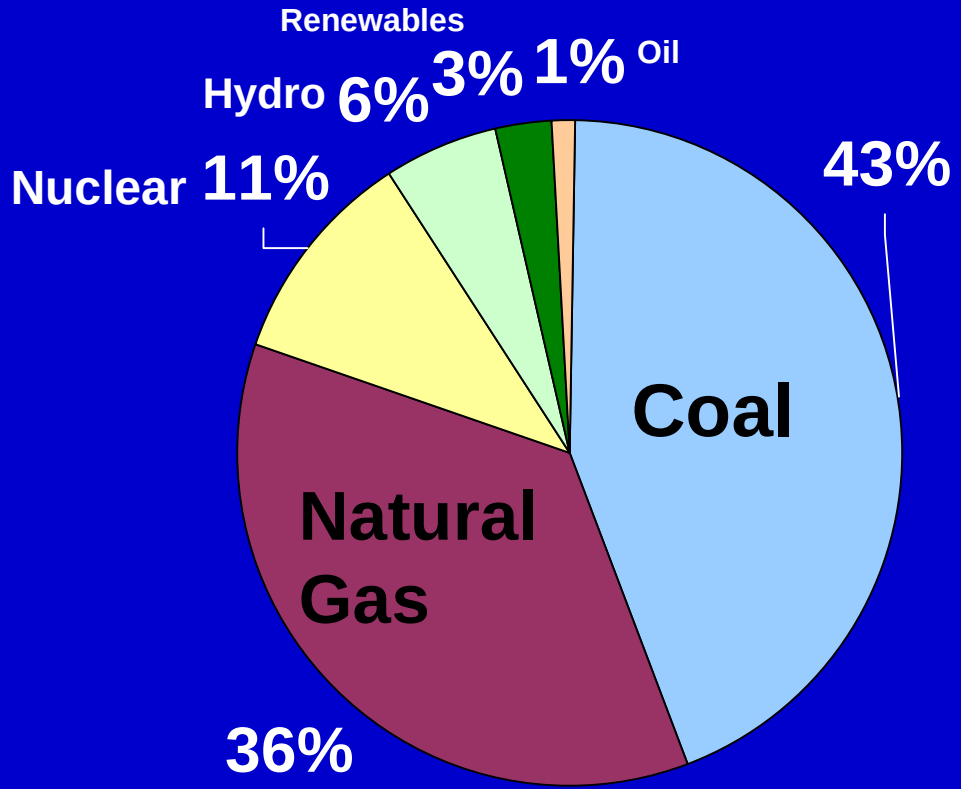
1999

3.2 Trillion kWh 69% fossil fuels



2020

4.5+ Trillion kWh 70% fossil fuels

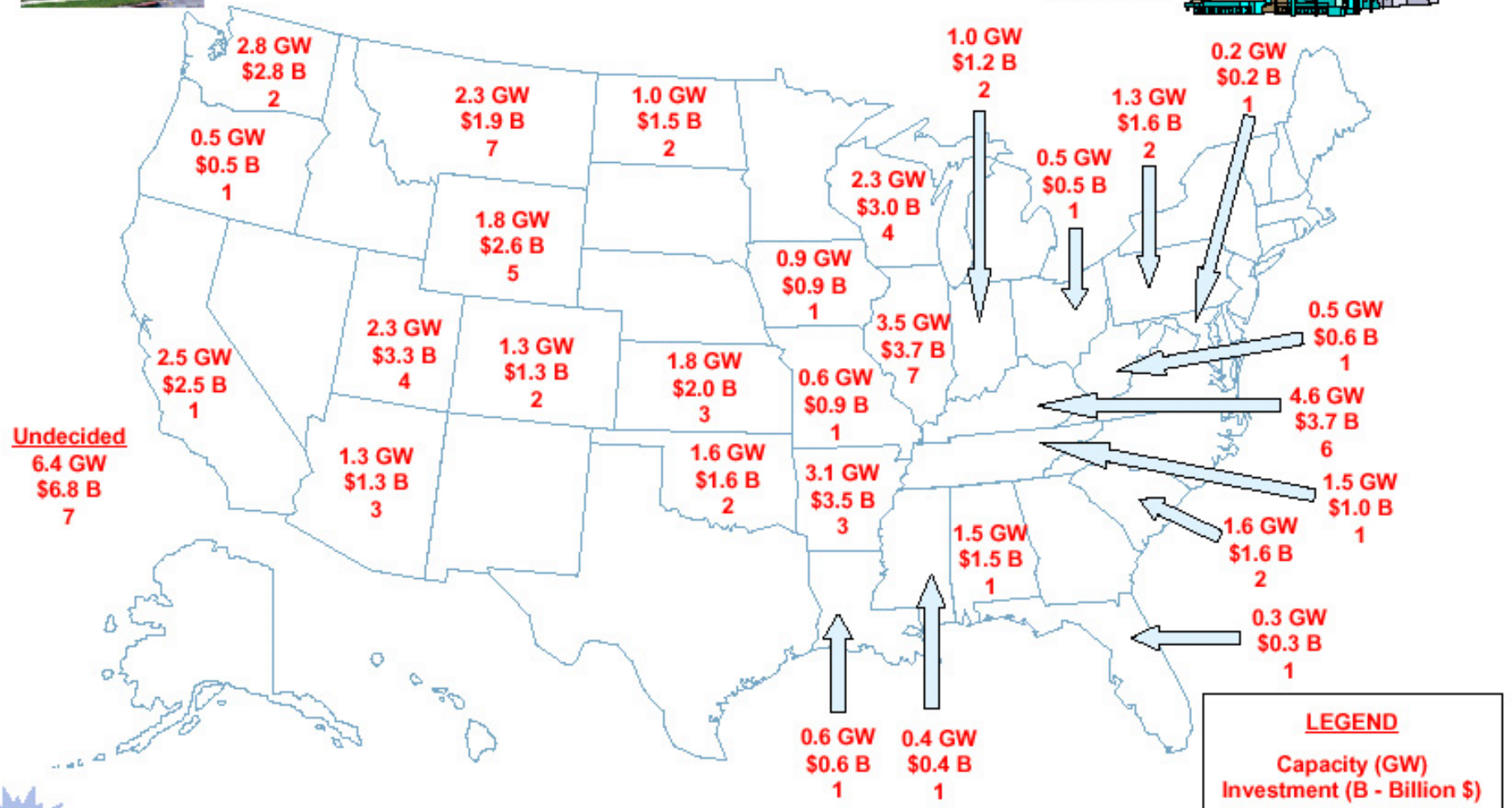


1999-2020 (Annual Energy Outlook 2001, Energy Information Administration Projection)

Coal's Resurgence in Electric Power Generation

Equivalent Power
for
50 Million Homes

75 Plants
50 GW
$ 53 Billion



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Retrofit & Repowering Potential for Coal?

Substantial !!!

Coal Nameplate Capacity
321 GW
44% of Total

240 GW (75%) of Fleet Capacity Is Prime Target For Increased Capacity Retrofit (40 GW potential in 3 years!)

80 GW (25%) of Fleet Capacity Is Prime Target For Repowering With Cleaner, Higher Efficiency Coal Technologies

Sources: National Coal Council

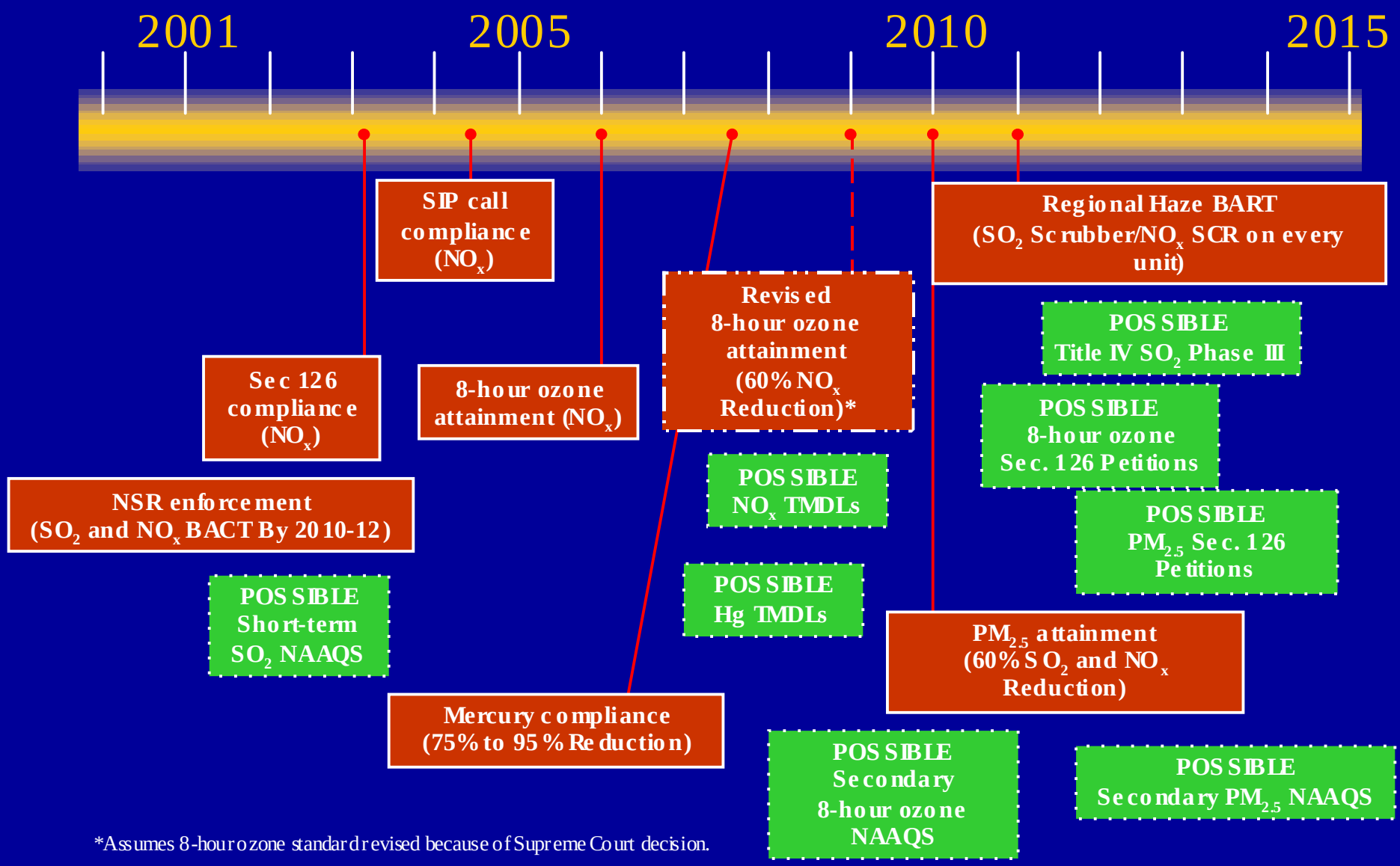
CHALLENGES TO USE OF COAL

- **Competitively-priced for electricity generation -- coal vs. natural gas**
- **Costs & time to construct -- permitting & construction**
- **Environmental challenges/regulations**
- **NIMBY (“not in my backyard”)**
- **Low public opinion**

Environmental Challenges: Air & Water

•Sulfur Dioxide	• SO2 Air Quality • Acidification • Fine Particles • Regional Haze
•Nitrogen Oxides	• Ozone formation • Fine Particles • Acidification • Regional Haze
•Carbon Dioxide	• Climate Change
•Mercury	• Toxic bioaccumulation
•Water	• ???

Environmental Regulatory Challenges



*Assumes 8-hour ozone standard revised because of Supreme Court decision.

Challenges to the Use of Coal

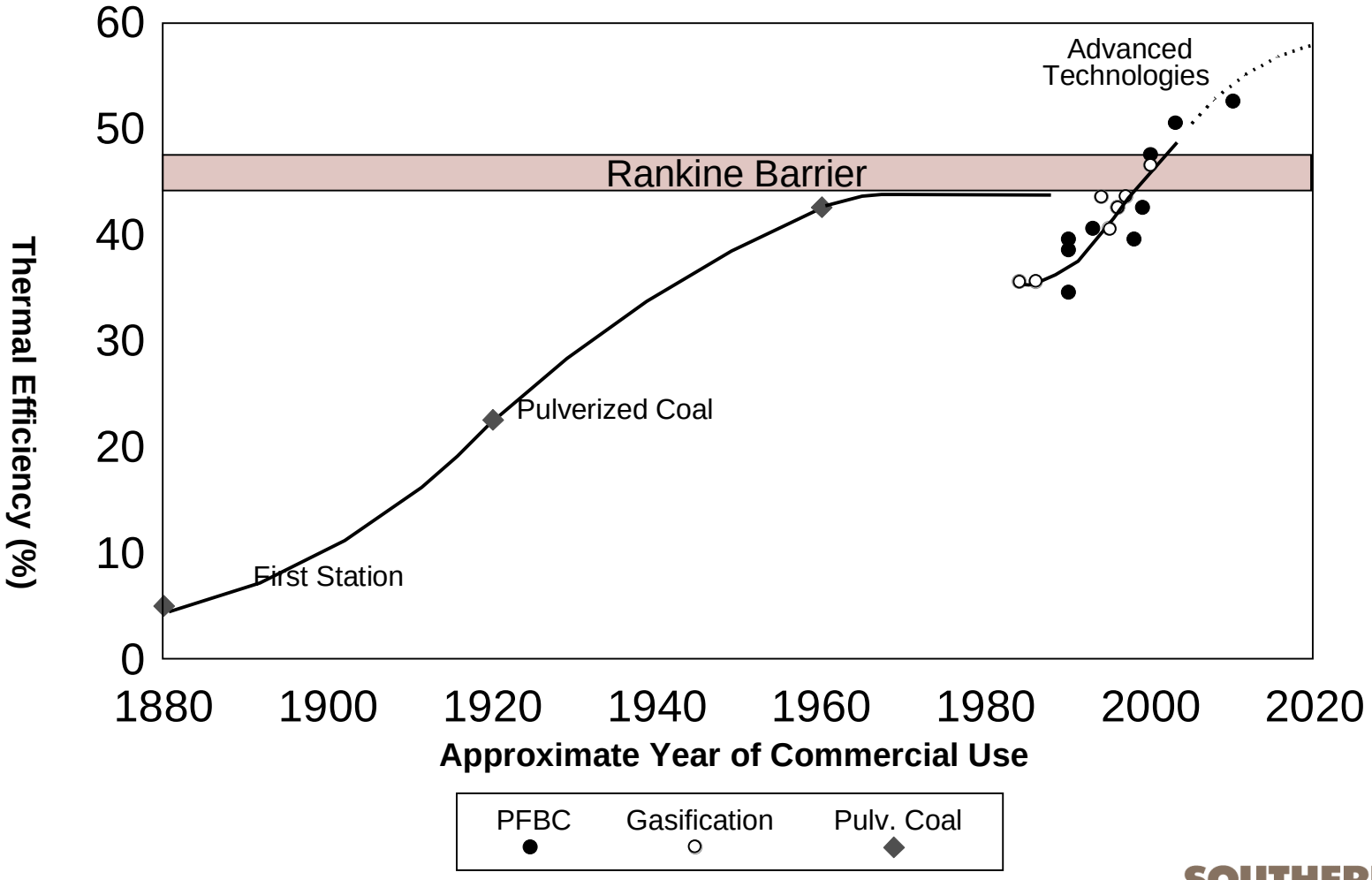
- If coal is, or perceived to be, a dirty fuel that harms the environment or the health of people;
- If coal is not cost competitive with other alternatives;
- If other fuels (e.g. natural gas) are as readily available as coal;
- Then, coal use for power generation will be more difficult

To insure that coal can meet these challenges now and in the future

- **Technology is essential**
- **Technology must be --**
  - **Cost competitive**
  - **Meet environmental standards**
- **Technology becomes a means by which --**
  - **to insure coal's competitiveness**
  - **to remove environmental issues as a concern for future coal use**

Challenges to the Use of Coal:

Evolution of Coal-Fired Power Plants



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To meet the Challenges to the Future Use of Coal: A clearly defined *technology development program*

CURC's Technology Roadmap

- Guides public/private cooperative efforts to develop, demonstrate and deploy technologies needed to achieve interim & long term technology goals for using coal
- Identifies near-term technologies that are
  - building blocks or critical components needed to insure success in the development of longer term technologies
  - high risk but high pay-off technologies that will insure cost effective environmental compliance
- Targets longer term technologies needed to insure that
  - new coal powerplants will emit de minimus or zero emissions
  - cost-effective methods are available to capture/sequester CO_2

Performance Targets for Coal Generation

(Performance Targets assume technologies in 2010 & 2020 are commercially available but not yet in widespread use)

Performance Target	Today	2010	2020
Capital Cost, $/kW	900 - 1300	900 - 1100	1000-1500*
Efficiency, %HHV	40	45	45 - 60
SO2, removal %	95	97	99
No_x lbs/mmbtu	0.1 - 0.3	0.08	0.05
HAPs *(hazardous air pollutants)*	define goals	meet goals	meet goals
Waste Utilization, %	15 - 30	50 - 75	100
Overall Emissions		Significant Reductions from Today's Technology	Deminimis Emissions

*The higher capital cost range includes installation/application of commercially-available CO2 sequestration technology; no such cost-effective control technology is commercially available in the 2010 timeframe although indirect sequestration techniques (e.g. carbon sinks) may be available.

The end results of a successful Advanced Coal Technology Program

- **By 2010** commercially available technology that will enable
  - existing coal based electricity generation powerplants to achieve cost-effective compliance with environmental requirements (e.g. SO2, NOx, PM, mercury)
  - the next generation of coal fired powerplants to be more efficient (less CO_2 emitted); cost competitive (with natural gas); and, environmentally superior to today's technology

The end results of a successful Advanced Coal Technology Program

- **By 2020** commercially available technology that will enable
  - cost-competitive electricity generation
  - production of chemicals or fuels from coal
  - virtually no emissions of conventional pollutants (SO2, NOx, PM, Hg) from coal use
  - “first-of-a-kind” commercial scale technology demonstrations able to capture and sequester CO_2 for commercial application after 2020

CURC HIGHEST PRIORITY TECHNICAL ISSUES OF COAL-FIRED POWER GENERATION RD&D

Technology Platforms	RD&D Issues	Time Frame and RD&D Funding (Public & Private) Million US Dollars	
		2000-2010	2010-2020
Existing Power Plants	• Reduce Hg and other HAPS to levels required • Evaluate low NOx burners to achieve 0.1lb. NOx/MMBtu • Increased use of solid waste • Integrate SO2 removal and particulate control to > 99%	684	750
Advanced Combustion-Based Steam Power Plants	• Higher temperature materials for boilers and steam turbines • Design of plant components and systems • Component testing under anticipated operating conditions	1248	1452
Gasification/Hybrid Power Plants	• High pressure solid feed injection • Slip stream testing of fuel cells • Fuel cell development/testing • 1800F metallic heat exchangers • Gasifiers for high moisture and ash coals • Enhanced monitoring of trace elements • Char combustion and gasification	2100	2200
Coal Liquid Fuels and Chemicals	• Fuels and Chemicals • Enabling Research to develop New Technologies • System Optimization • Hydrogen Production via gasification	575	591
CO2 Management	• Development and demonstration for combu… separation • Development and demonstration for gasificatio… separation • Fixation/reuse and geological, terrestrial, and ocean sequestration	1250	1750
TOTAL RD&D COSTS		**5,857**	**6,743**
TOTAL OVER 20 YEARS			**12,600**

20 years: $12.6billion

Technology Roadmap: Coal Gasification Technology Needs

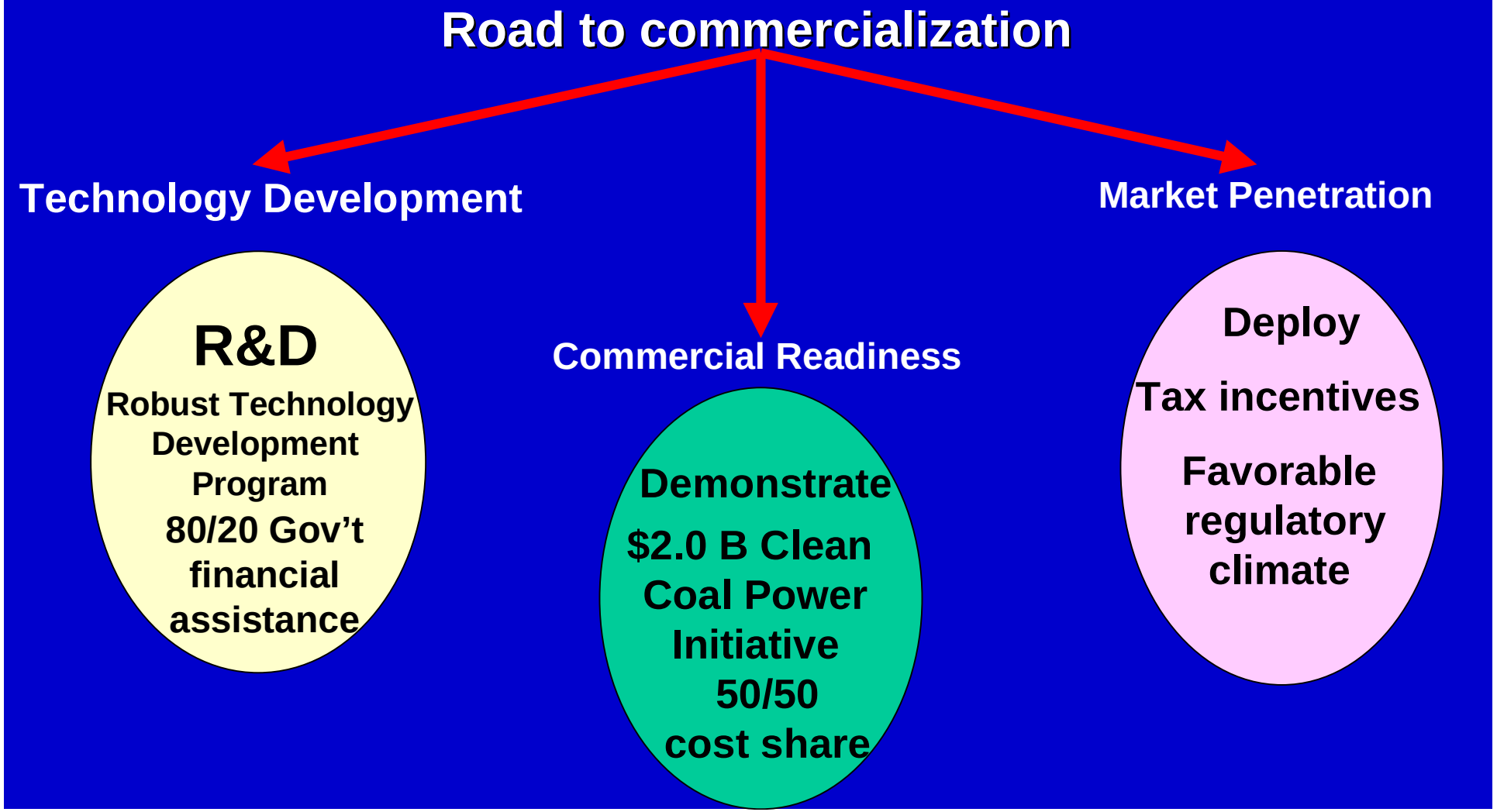
- High Pressure Solid Feed Injection
- Slip Stream Testing of Fuel Cells
- Fuel Cell Development/Testing
- 1800F Metallic Heat Exchangers
- Gasifiers for High Moisture and Ash Coals
- Enhanced Monitoring of Trace Elements
- Char Combustion and Gasification

Technology Roadmap: Estimated Costs to Complete Coal Gasification R,D & D

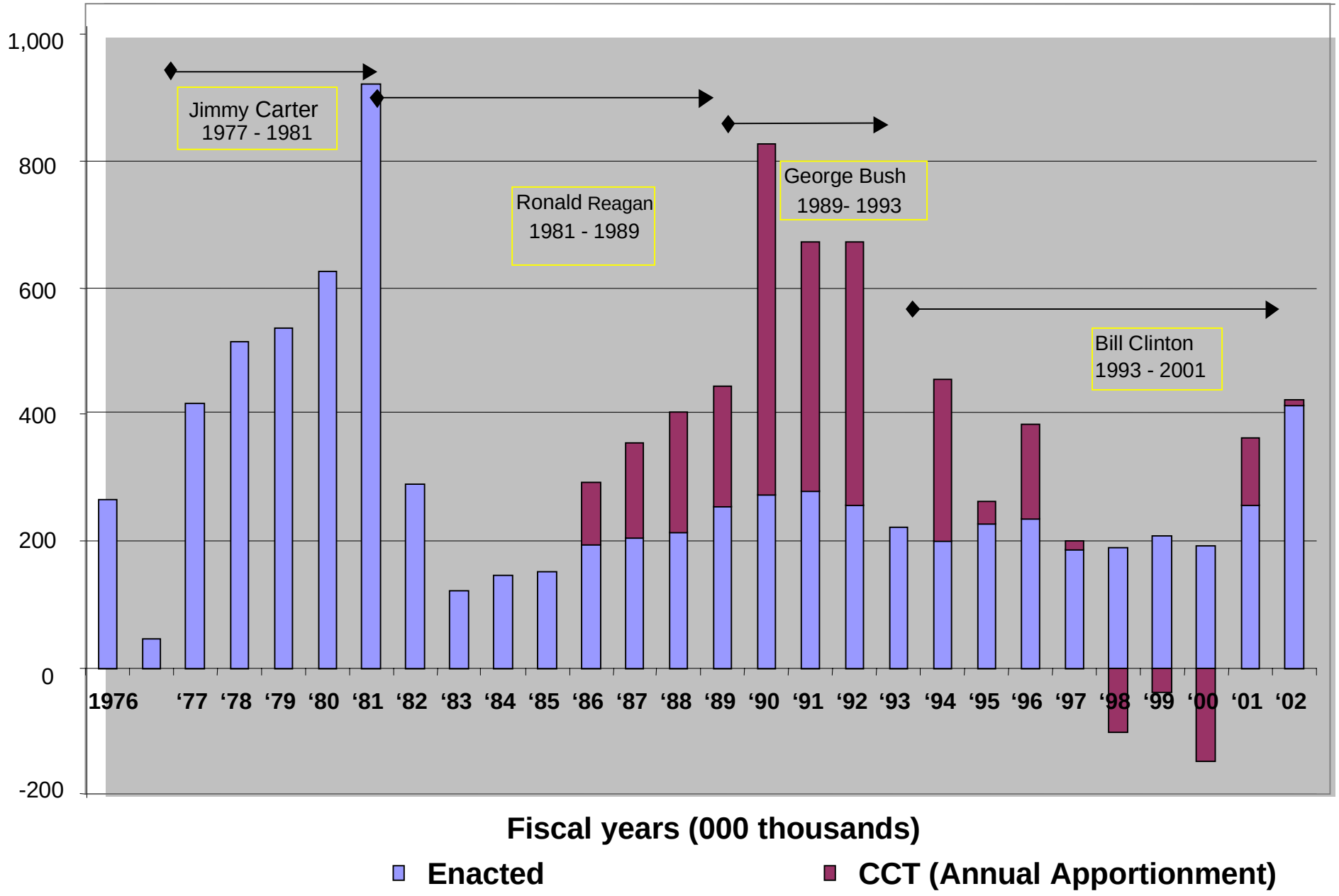
	R&D (musd)	DEMO (musd)
2000-2010	1400	700
2010-2020	450	1750
Subtotal	1850	2450

TOTAL: $4,300

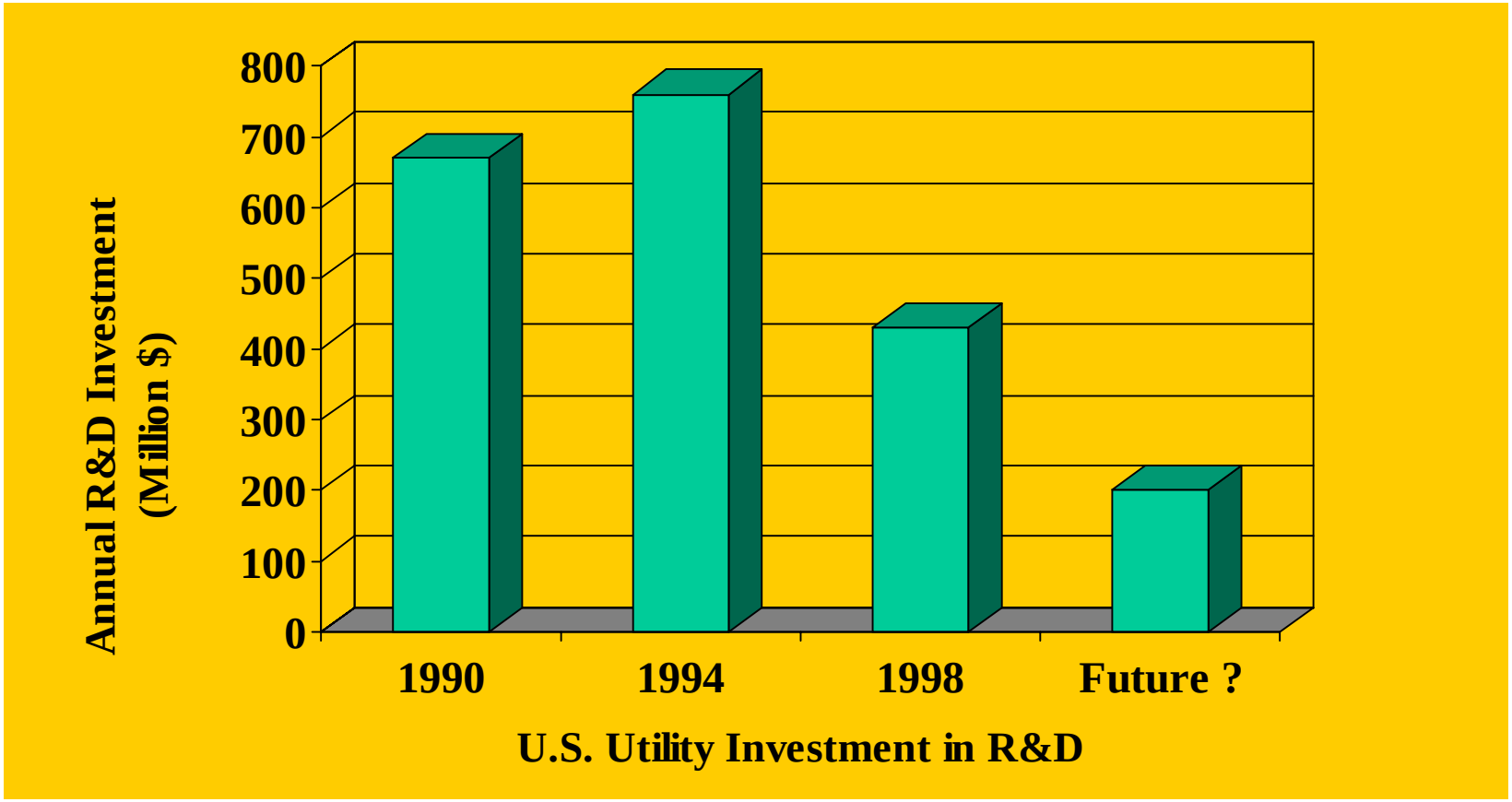
CURC's Coal Investment Strategy



No Growth Investment Trend by Government

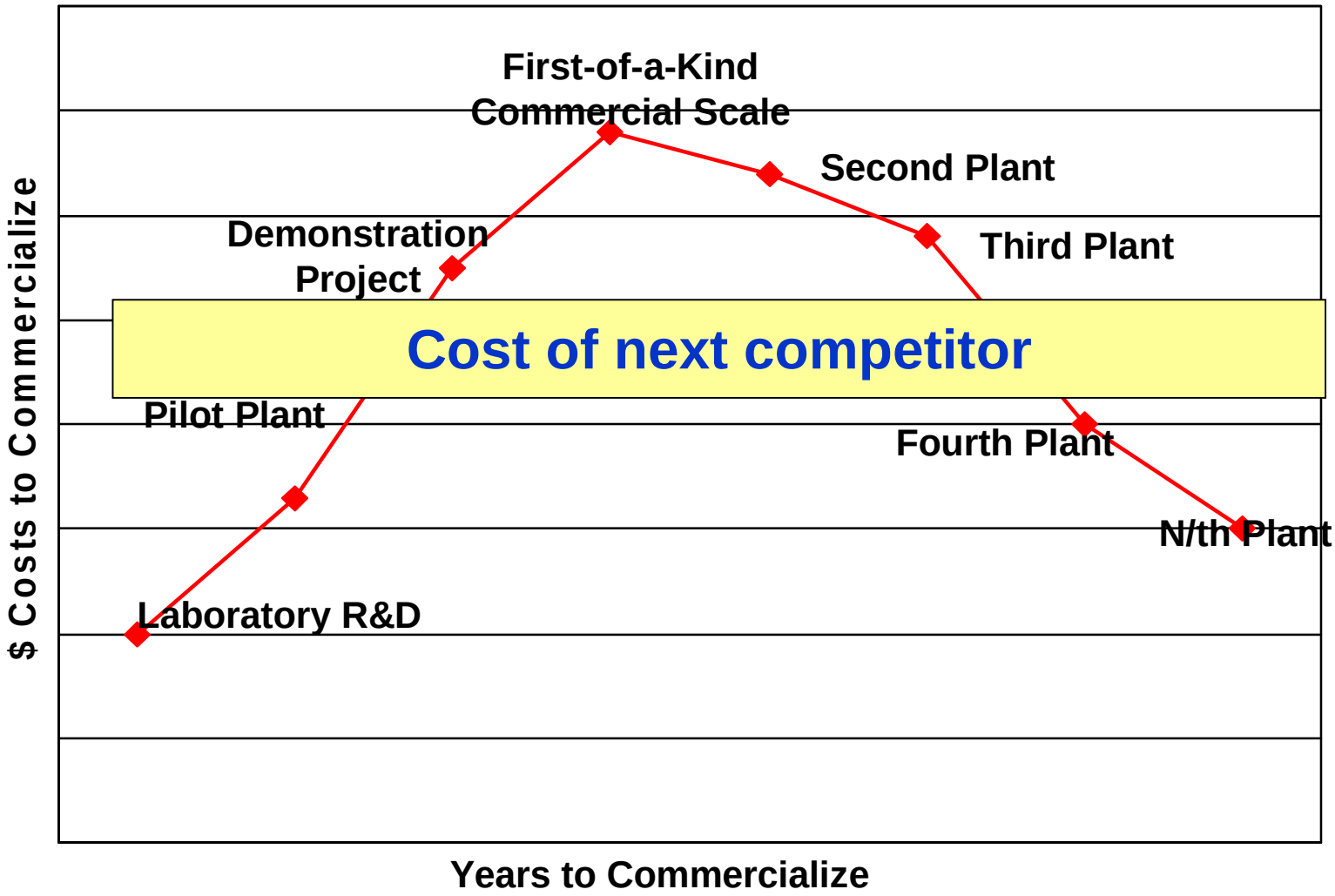


Downward Investment Trend By Utilities

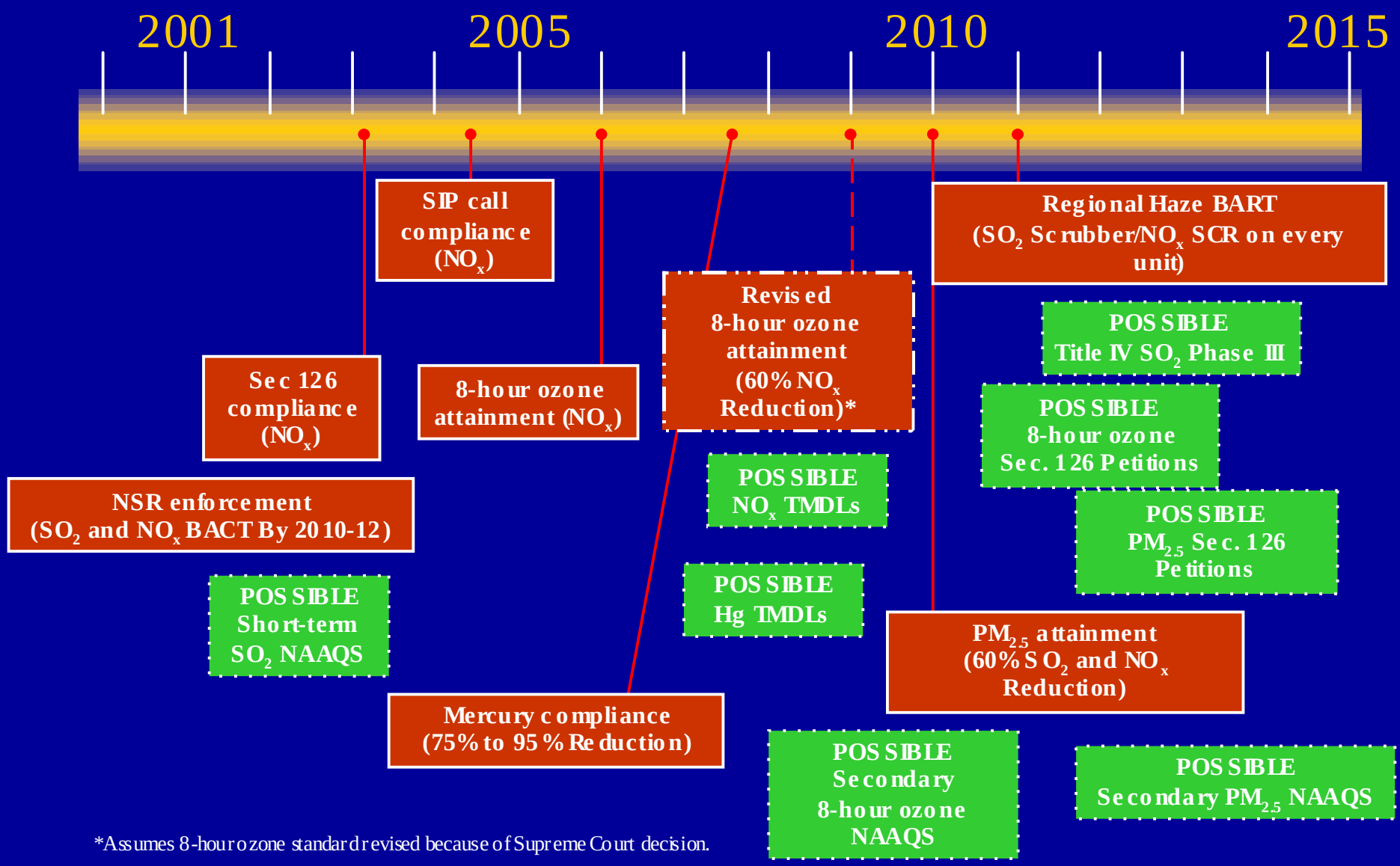


Source: EPRI Roadmap

Technology R&D to Commercialization



Environmental Regulatory Challenges



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Government's Role

- Promote technologies that are responsive to public needs
- Promote fuel diversity and reliability of affordable supplies
- Share technical and financial risks of technology development required to meet public needs and promote public/private partnerships

National Electricity and Environmental Technology Act, S. 60 and H.R. 2323

- **Title I**
  - Accelerated R&D for new and existing coal-based generation facilities
  - Power Plant Improvement Initiative
- **Title II**
  - Tax credits for emission reduction and efficiency improvements on existing coal-based generation facilities
  - Regulatory incentives
- **Title III**
  - Tax credits for early commercial applications of advanced clean coal technologies
  - Regulatory incentives
  - Risk pool
- **Title IV**
  - Extension of Title II and III tax credits to public power, rural electric cooperatives and government facilities

Power Plant Improvement Initiative Precursor to CCPI:

- Congressionally mandated redirection of $95 Million of previously appropriated clean coal technology funds
- Objective: Electricity reliability with near-term technological solutions for coal-fired electric power generation
- 24 Proposals, 8 projects selected >$110 Million Projects
  - Emissions control strategies - 5 projects
  - Advanced control schemes - 2 projects
  - Waste handling/reduction - 1 project

The Clean Coal Power Initiative (CCPI)

- Cost-shared partnership between the industry and government to provide early demonstrations of advanced coal-based, power generation technologies
- The goal is to accelerate commercial deployment of advanced technologies. This ten-year initiative will be funded at a total federal cost-share estimated at $2 billion with matching industry cost-share of at least 50%
- First solicitation to be issued February, 2002; submissions June, 2002; selections December, 2002

How does CURC insure completion of the Technology Roadmap?

- #1. Agreement among the key players
- #2. Adequate funding & other legislative authorities to undertake necessary R&D, demonstration and deployment projects
- #3. Industry-led partnerships with DOE, national laboratories, state programs & universities
- #4. Discouragement of actions that preclude timely development & use of technologies

#1 - Agreement among the key players

- **The Roadmap document is used to find concensus among CURC members, the Department of Energy (DOE), the White House, Congress and other interest groups & stakeholders**

2 - Adequate Funding and Legislative Authorities

- **CURC has identified total estimated costs to complete the Technology Roadmap**
- **House energy bill (HR4) and Senate energy bill (S. 1766) includes $160 to $175 million per year for coal R&D**
- **House energy bill (HR4) and Senate energy bill (S. 1766) includes 10 year and $2.0 billion clean coal demonstration program**
- **House energy bill (HR4) includes $3.3 billion in tax incentives; Senate bill includes $1.9 billion in tax incentives**

2 - Adequate Funding and Legislative Authorities

House energy bill passed the House in August, 2001 --

$500 million over three years for coal R&D program

$2.0 billion/10 years for coal demonstrations using CURC

80% of demonstration funds directed to gasification

$3.3 billion tax incentives for limited number of advanced coal utilization projects

Senate energy bill (S. 1766) being debated by the Senate --

$2.5 billion 5 year authorization for fossil energy R&D of which about 40% is coal based

$2.0 billion/10 years for coal demonstrations tied to Vision 21 objectives and targets

lignite & precombustion technologies with emphasis on gasification & carbon sequestration

$1.9 billion tax incentives for limited number of advanced coal utilization projects

#3 - Industry-led partnerships

- CURC Technology Roadmap assumes public/private cost share demonstrations
- Support President's $2.0 billion clean coal initiative
- Government must have authority to contract for entire amount of federal share in a multi-year & multi-million dollar demonstration project
- $2.0 billion program should focus upon demonstrations for subsequent widespread use

#4 - Comment on actions that could preclude development

- Identify regulations that will preclude or enhance development or use of new technologies
- Comment upon proposed actions in context of impacts upon technology development and use

For More Information:

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